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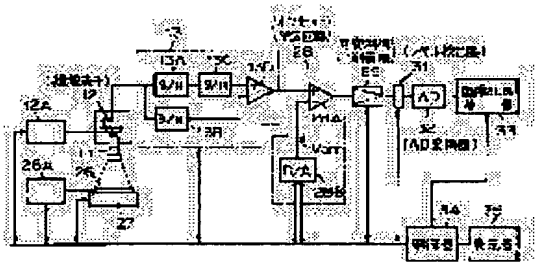
(54) LIQUID CRYSTAL PANEL INSPECTION INSTRUMENT

(57)Abstract:
PURPOSE: To detect fine defects and pulse-like defects per pixel by arranging an offset removal circuit and a variable gain amplifier for amplifying a signal cleared of offset at a high magnification.
CONSTITUTION: A liquid crystal panel 26 to be inspected is taken with an image pickup element 12 and a taken signal is converted into a pixel signal to be taken out with a correlation double sampling circuit 13. Then, a pixel signal cleared of an offset voltage with an offset removal circuit 28 is amplified with a variable gain amplifier 29 to be applied to an A/D converter 32. A level detector 31 monitors an input allowable range of the converter 32 to control the offset voltage of the circuit 28 and the gain of the amplifier 29. In this manner a fine voltage change of a defect part can be amplified greatly by controlling the offset voltage and the gain of the amplifier 29. A digital pixel signal of the converter 32 is inputted into an image processor 33 and the degree of defects, the pixel position of the defect part and the like are specified to show the results of inspection on a display device 35.



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[Claim(s)]

[Claim 1] A. the image sensor which picturizes the screen of an inspected liquid crystal panel, and B. -- the offset removal circuit which removes the offset voltage of the image pick-up signal outputted from this image sensor, the variable gain amplifier which amplify the image pick-up signal with which offset voltage was removed in C. offset removal circuit for a high scale factor, and D. -- the image processing system which detects having changed the image pick-up signal which amplified with this variable gain amplifier beyond a predetermined value, and detects the defect of inspected liquid crystal -- ** -- the liquid-crystal-panel test equipment which constituted as it is alike.

[Claim 2] Liquid crystal panel test equipment constituted so that two or more image sensors indicated to claim 1 might be formed, the image pick-up signal acquired from two or more of these image sensors might be alternatively given to an offset removal circuit and the defect of two or more inspected liquid crystal panels might be inspected by turns with a common offset removal circuit and an image processing system.

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention detects the defect of the liquid crystal panel used for drops, such as a television receiver or a personal computer, and relates to liquid crystal panel test equipment classifiable to an excellent article and a defective.

[0002]

[Description of the Prior Art] As one method of not depending the defect of a liquid crystal panel on viewing, but detecting it automatically, the screen of an inspected liquid crystal panel is picturized with image pick-up equipment, and how to detect the defect of a liquid crystal panel from the variation of the image pick-up signal is considered.

[0003]

[Problem(s) to be Solved by the Invention] It is possible to use a commercial television camera as image pick-up equipment. However, when the television camera marketed is used as liquid crystal panel test equipment, un-arranging [which cannot detect a defect in each pixel unit of a liquid crystal panel] arises. That is, it is because the low pass filter is prepared in the system way of an image pick-up signal in order to remove a RF noise to a commercial television camera as the reason. Furthermore, since it does not have an offset removal function in a television camera, fluctuation of the minute amplitude cannot be amplified greatly and cannot be taken out. For this reason, there is un-arranging [which cannot detect a minute defect]. The configuration of the outline of a commercial television camera is shown in drawing 4 .

[0004] 12 in drawing shows the semi-conductor image sensor called CCD. Image formation of the image of a photographic subject is carried out to this

image sensor 12 through the image pick-up lens 11, photo electric conversion of that image is carried out, and the line sequential signal corresponding to an image is outputted. The line sequential signal outputted from the image sensor 12 is sampled in the correlation duplex sampling circuit 13, and a pixel signal is taken out. This correlation duplex sampling circuit 13 is formed in order to remove a sampling noise. That is, sample hold of the black level BL of the image pick-up signal shown in drawing 5 by 1st sample hold circuit 13A is carried out, and although a pixel signal is acquired by taking out the difference of the sample hold value and signal part S, while carrying out sample hold of the level of the signal part S by 2nd sample hold circuit 13B, sample hold of the black level BL by which sample hold is carried out to 1st sample hold circuit 13A by 3rd sample hold circuit 13C is carried out to coincidence. The noise of the sampling pulse of the inphase generated by this coincidence sample hold in 2nd sample hold circuit 13B and 3rd sample hold circuit 13C is removed. 14 shows the timing signal generator which gives a timing signal to an image sensor 12 and the correlation duplex sampling circuit 13.

[0005] A pixel signal can be acquired by taking out the difference between black level BL and the signal part S in the correlation duplex sampling circuit 13. A pixel signal serves as direct current voltage of a fixed value for every pixel in the part of the image of fixed brightness, as shown in drawing 5 B. The pixel signal outputted from the correlation duplex sampling circuit 13 is supplied to a variable gain amplifier 23 through a low pass filter 15, the gamma correction circuit 16, the White clipping circuit 17, the blanking mixing circuit 18 and the pedestal addition circuit 19, and the synchronizing signal addition circuit 21, and the correction of track is carried out to the pixel signal which has the proper amplitude with a variable gain amplifier 23,

and it is outputted through an output circuit 24.

[0006] When 1 pixel of an image sensor 12 possesses the defect of photo-electric-conversion impossible, the low pass filter 15 is formed in order to prevent that the defect appears directly as a pixel signal. That is, even if the defect for 1 pixel occurs in the shape of a pulse, wave filtration of this pulse wave is carried out, and he changes into a signal with a low **** value, and is trying not to appear on the screen of a drop strongly.

[0007] Thus, in a commercial television camera, since the low pass filter has removed the high frequency component in order to remove that the defect of a pixel unit appears in the image projected on a monitor, supposing it uses this television camera for defective detection of a liquid crystal panel, un-arranging [which cannot detect the defect of a pixel unit] will arise. Moreover, although the variable gain amplifier 23 is formed with the commercial television camera, the max of the gain is about about 10 times. Since the max of the gain of a variable gain amplifier 23 is about 10 times even if 19.9mV voltage variation exists in 20mV and a defective part by the normal part as it follows, for example, the output of the correlation duplex sampling circuit 13 is shown in drawing 5 B, as shown in drawing 5 C, it is set to 200mV in a normal part, and is set to 19.9mV in a defective part. Therefore, 1mV fluctuation must be detected in this case, and a defect must be pointed out. however, a 10-bit A-D converter -- a maximum of 1 -- the case where the AD translation of the pixel signal of V is carried out -- 1mV -- min -- it becomes resolution. That is, it is decided by whether 1 bit of the least significant digit with an AD translation value of 10 bits stands on "1" logic whether there is any 1mV difference. Since the least significant digit of a digital sign produces a count error, the dependability of the least significant digit is low. There is a fault which cannot detect the minute defect which

produces only an about 1mV difference from normal values after all with sufficient dependability.

[0008] The purpose of this invention tends to offer the liquid crystal panel test equipment which can also detect the defect of the shape of a pulse constituted by the minute defect and the high frequency component which produce only a minute difference from normal values.

[0009]

[Means for Solving the Problem] Although it is the same as the former to change into a pixel signal the image pick-up signal outputted from an image sensor, and to take it out by the correlation duplex sampling circuit, in this invention, an offset removal circuit is established in the output side of a double sampling circuit. The signal which removed the offset component greatly as much as possible out of the pixel signal, and removed offset by this offset removal circuit is amplified greatly as much as possible, and a changed part is expanded greatly, it gives an A-D converter, a small level change of a pixel signal is taken, and it is going to detect the defect of a liquid crystal panel.

[0010] According to the configuration of this invention, since the offset component contained in a pixel signal is removed greatly, the remainder serves as a signal of sufficiently small level. Consequently, the remaining signal which removed the offset component can be amplified greatly, and can be inputted into an A-D converter. Therefore, the minute defect to which a minute level change is also expandable is also detectable.

[0011]

[Example] Drawing 1 shows one example of this invention. The point that 11 shows an image pick-up lens and an image sensor [like CCD] whose 12 is, and 13 shows a correlation duplex sampling circuit in drawing 1 is the same

as explanation of drawing 4 . The back light equipment with which 26 gives an inspected liquid crystal panel to this inspected liquid crystal panel 26, and 27 gives the illumination light is shown. Moreover, the liquid crystal panel driving gear with which 26A gives a linear-scanning signal, a synchronizing signal, etc. to the inspected liquid crystal panel 26, and 12A show the driving gear which drives an image sensor 12.

[0012] Light is given from a tooth back by back light equipment 27, light penetrates the inspected liquid crystal panel 26 alternatively by closing motion of the liquid crystal cell which constitutes a pixel, and it displays an image. An image sensor 12 is made to picturize a part of the image here, where the whole surface is displayed on white. That is, some fields of the inspected liquid crystal panel 26 are picturized with an image sensor 12, an image pick-up location is shifted one by one, and the whole surface of the inspected liquid crystal panel 26 is inspected. For this reason, it is good to carry the inspected liquid crystal panel 26 in a X-Y migration stage (not especially shown).

[0013] An image pick-up signal is outputted to line sequential from an image sensor 12, and this image pick-up signal is changed into the pixel signal which consists of the difference of black level and a white level in the correlation duplex sampling circuit 13, and is taken out. In this invention, the offset removal circuit 28 is established in the output side of the correlation duplex sampling circuit 13. For example, analog adder 28A and DA converter 28B which gives offset voltage to this analog adder 28A can constitute this offset removal circuit 28. The digital value corresponding to offset voltage is given to DA converter28B from a controller 34, the DA translation of this digital value is carried out, and it is offset voltage VOFF of that analog. The subtraction input terminal of analog adder 28A is given.

[0014] The pixel signal which removed offset voltage in the offset removal circuit 28 is given to a variable gain amplifier 29, is amplified with this variable gain amplifier 29, and is given to A-D converter 32. The level detector 31 which supervises the level of a pixel signal to the input side of A-D converter 32 here is formed. This level detector 31 has judged whether the level of the pixel signal given to A-D converter 32 is contained in **500mV of input tolerance of A-D converter 32. Offset voltage VOFF which gives the detecting signal to a controller 34 and is given to the offset removal circuit 28 when the level of the pixel signal inputted into A-D converter 32 has crossed the input tolerance of A-D converter 32 A value and the gain of a variable gain amplifier 29 are controlled.

[0015] That is, the variable gain amplifier is always controlled by the condition of being 100 times many as the maximum gain. A pixel signal is inputted into a level detector 31 through the offset removal circuit 28 and a variable gain amplifier 29 in this condition. Offset voltage VOFF According to a zero state, in this example, since a 200mV pixel signal is given to a variable gain amplifier 29, a variable gain amplifier 29 still outputs a pixel signal with the electrical potential difference of 200mVx100=2V. If this electrical potential difference of 2V is given to a level detector 31, a level detector 31 will be judged to be overflow and will input that judgment result into a controller 34. A controller 34 is offset voltage VOFF first. The control raised gradually is begun. That is, offset voltage VOFF The digital value given to DA converter 28B to generate is made to increase gradually, and it is offset voltage VOFF. It raises gradually.

[0016] Offset voltage VOFF As it amounts to 15V and the output of the offset removal circuit 28 shows drawing 2 C, when it is changed into a 5mV pixel signal, it judges with the level detector 31 having gone into the permission

input range of A-D converter 32, and it is offset voltage VOFF of a controller 34 by the decision output. Increment control is stopped and it is offset voltage VOFF. It is determined. In addition, when a big defect is included in a pixel signal, the pixel signal which has the larger amplitude than 5mV in a defective part occurs. In such a case, offset voltage VOFF If it raises to 15mV, it is offset voltage VOFF to the part of this defective signal. Since it starts, it is offset voltage VOFF. Increment control controls the level of the pixel signal which is only stopped because of front level, replaces with this, extracts the gain of a variable gain amplifier 29, and is inputted into a level detector 31 from the amplitude of a defective signal to go into the tolerance of A-D converter 32.

[0017] Thus, offset voltage VOFF By controlling the gain of a variable gain amplifier 29, the gain of a variable gain amplifier 29 can be controlled greatly as much as possible, and the electrical-potential-difference change with a minute defective part can be amplified greatly. Consequently, the pixel signal of the minute defective part of the inspected liquid crystal panel 26 can be emphasized as shown in drawing 2 D, and it can input into A-D converter 32, and an AD translation can be carried out.

[0018] The digitized pixel signal which is outputted from A-D converter 32 is inputted into an image processing system 33, pinpoints extent of a defect, the pixel location of a defective part, etc., and displays an inspection result on a drop 35. Drawing 3 shows the deformation example of this invention. In this example, 2 sets of image sensors 12 are formed, and the case where it constitutes so that the inspected liquid crystal panel 26 of two sheets can be inspected by turns with 2 sets of these image sensors 12 is shown.

[0019] That is, the image pick-up signal of 2 sets of image sensors 12 is chosen with a change-over switch 37, and one of image pick-up signals is

inputted into the correlation duplex sampling circuit 13, the same processing as drawing 1 is performed below, and it incorporates to an image processing system, and it constitutes so that a quality may be judged. Thus, the advantage which can inspect continuously is acquired, without waiting for time amount until the inspected liquid crystal panel 26 is stabilized to a switch of a display condition by switching a change-over switch 37, whenever it changes the display condition of the inspected liquid crystal panel 26 by constituting so that the inspected liquid crystal panel 26 of two sheets can be inspected by turns using 2 sets of image sensors 12.

[0020] That is, the liquid crystal panel has the fault which will require time amount by the time it is stabilized in the new condition of having changed (about 1 second), if the conditions of a display are changed. Therefore, when changing a display like red, blue, green, and white in the case of the liquid crystal panel of a color display form and inspecting in the state of each of that color, according to the configuration of the test equipment of drawing 1 , the inspected liquid crystal panel is indicated by red, and it inspects by waiting for 1 second. When change a display blue, it waits for it for 1 second, and inspection is started, when a red inspection was completed, and a blue inspection is completed, it is made to change green and inspects by waiting for a display for 1 second. Moreover, it inspects by switching to a white display and waiting for 1 second.

[0021] Thus, since the latency time must be established whenever it changes the display condition of the inspected liquid crystal panel 26, there is un-arranging [which cannot perform inspection efficiently]. On the other hand, as shown in drawing 3 , when it considers as the configuration which inspects the inspected liquid crystal panel 26 of two sheets by turns, while changing the display condition of one inspected liquid crystal panel 26, the

liquid crystal panel of another side can be inspected, and the advantage which can examine efficiently is acquired by performing this by turns.

[0022]

[Effect of the Invention] The image pick-up signal which is outputted from an image sensor 12 according to this invention as explained above is changed into a pixel signal in the correlation duplex sampling circuit 13, and that pixel signal is offset voltage VOFF in an offset removal circuit. It is removed. By removing this offset voltage VOFF, where a normal pixel signal part is held down to permission input within the limits of A-D converter 32, the pixel signal of a minute defective part can fully be amplified. Consequently, since a defective part can be amplified greatly and can carry out an image processing, the difference in slight level is also detectable for every pixel. Therefore, the test equipment which can detect the minute defect for every pixel of a liquid crystal panel can be constituted.

[0023] Furthermore, in this invention, since a low pass filter is not included in a signalling channel, the signal of a high frequency component is also detectable. Therefore, detection of a minute defective part is attained also at this point. Moreover, as shown in drawing 3 , the effectiveness of inspection can be improved by forming two or more image sensors, and the advantage which can inspect a lot of liquid crystal panels in a short time is acquired.

[Brief Description of the Drawings]

[Drawing 1] The block diagram showing one example of this invention.

[Drawing 2] The wave form chart for explaining actuation of this invention.

[Drawing 3] The block diagram showing the deformation example of this invention.

[Drawing 4] The block diagram for explaining a Prior art.

[Drawing 5] The wave form chart for explaining actuation of a Prior art.

[Description of Notations]

11 Image Pick-up Lens

12 Image Sensor

13 Correlation Duplex Sampling Circuit

28 Offset Removal Circuit

29 Variable Gain Amplifier

32 A-D Converter

33 Image Processing System

34 Controller

35 Drop